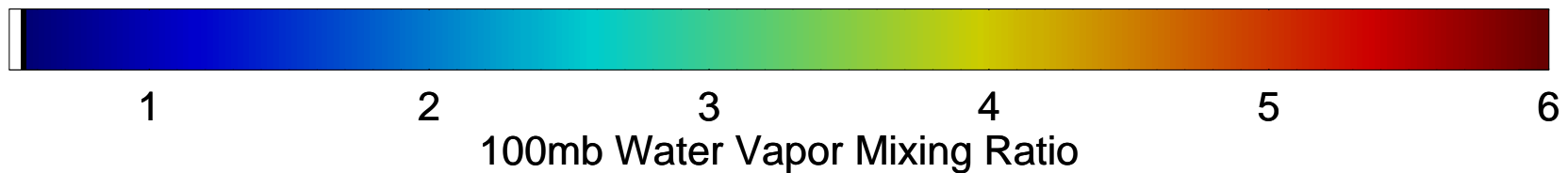
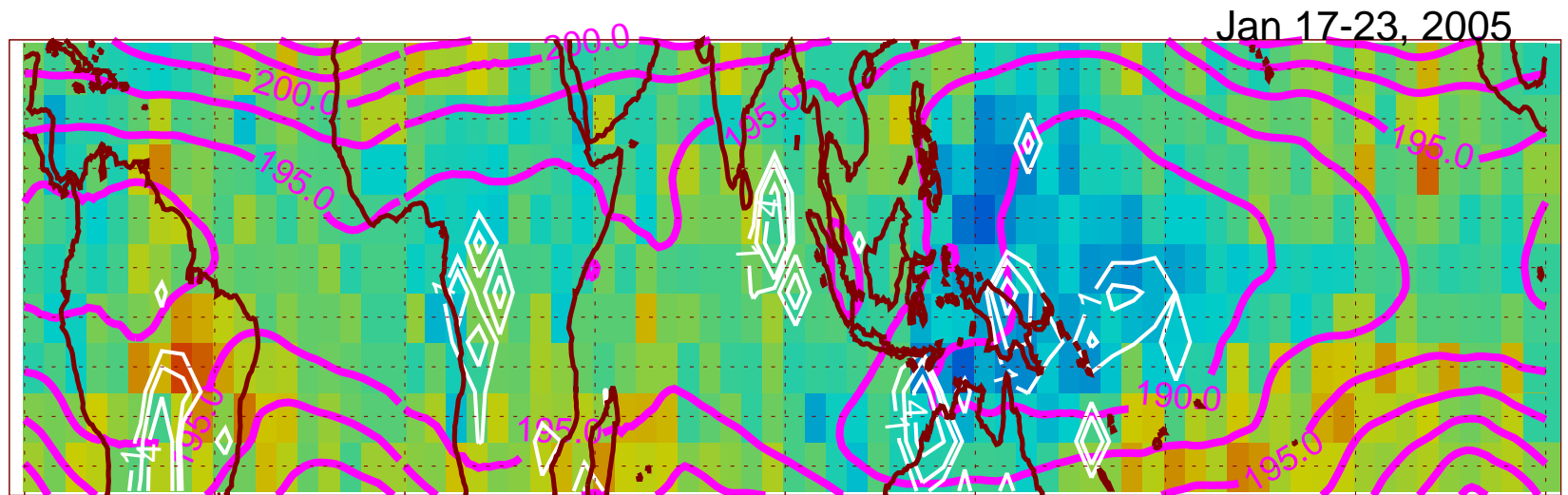


# **Water Vapor in the Boreal Winter Tropical Tropopause Layer: Results from a trajectory-based microphysical model and comparison with Aura MLS observations**

**Leonhard Pfister, Eric Jensen**, NASA Ames Research Center

- Mid-January shows very different water vapor distributions in 2005 and 2006
- Can we explain both of these with a detailed microphysical model calculation?

## Water Vapor, Temperature, and Convective Frequency at 100mb



## Goals and Questions

- How well can we simulate water vapor for these two midwinter periods with “conventional” microphysics and dynamics?
- How important is convection in maintaining TTL water vapor and to what altitude?

# 1-D Trajectory Microphysical Model Procedure

- Inputs
  - 40 day diabatic back trajectories from a 5 by 5 grid of tropical points using GEOS-4 analyses
  - Time-height curtains of T along these trajectories with radiosonde adjustment
  - Convective cloud top thetas from tracing curtains through 3-hourly satellite imagery.
  - Adjustment to satellite brightness temperatures
  - Initial water vapor profile

## Model Procedure – Continued

- Model (Jensen and Pfister, 2004)
  - 1-d full microphysical model (height) with interactive heating (vertical motion) dependent on vapor and T (not clouds).
  - Use conventional microphysics ( 160% sat ratio for nucleation; standard smr values)
  - Set water vapor to local smr up to cloud top theta.

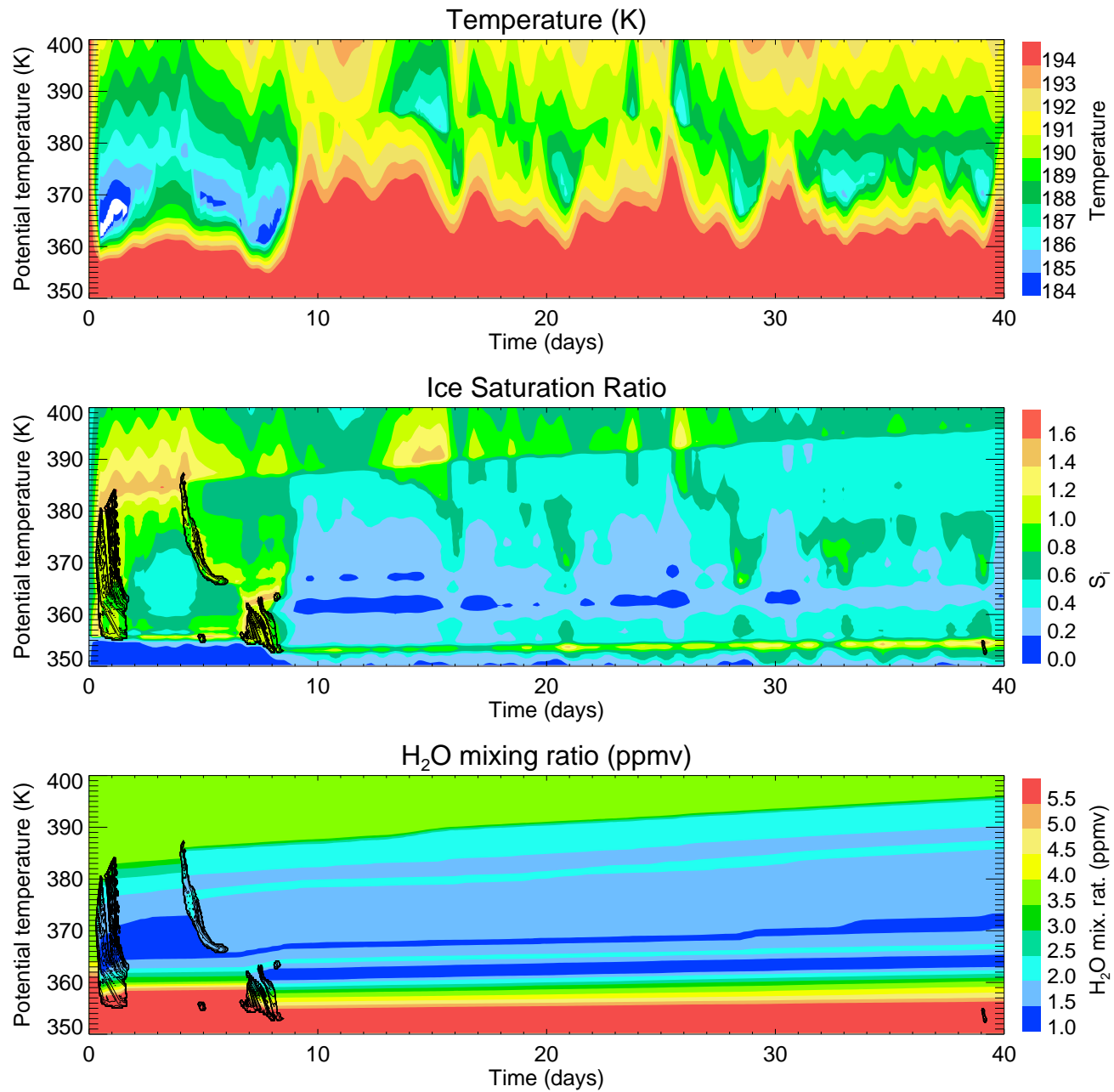
## Model Procedure – Continued

- Output
  - Final water vapor profile at 5 by 5 degree tropical grid
  - Cloud and particle size distributions (alt,lat,lon,time)

## Cases run

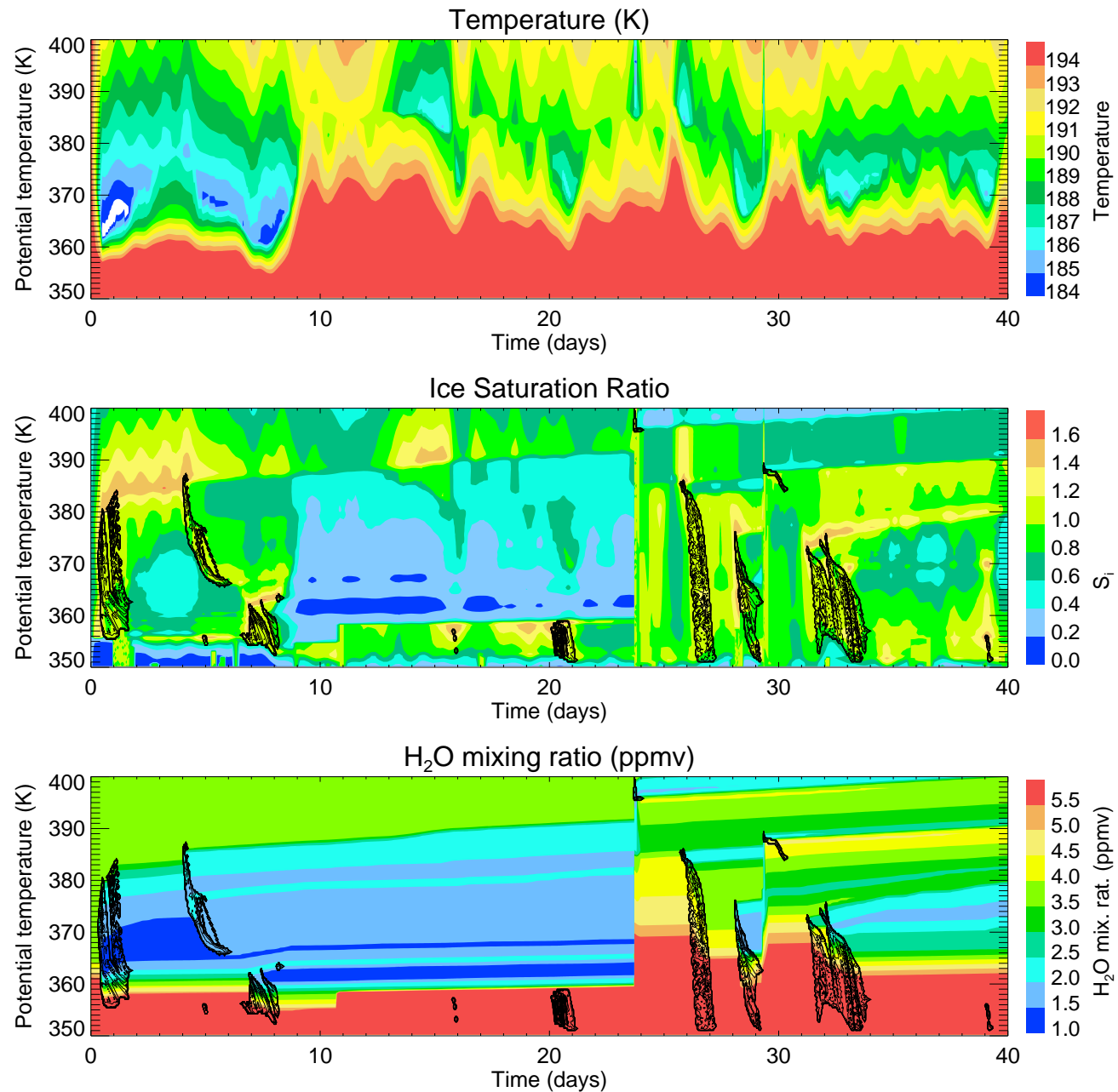
- Nonconvective (2005 and 2006)
- Convective (2005 and 2006)
- Enhanced Convective (2005 and 2006)
- Enhanced Convective with doubled heating (2006)

## Sample single trajectory evolution – no convection

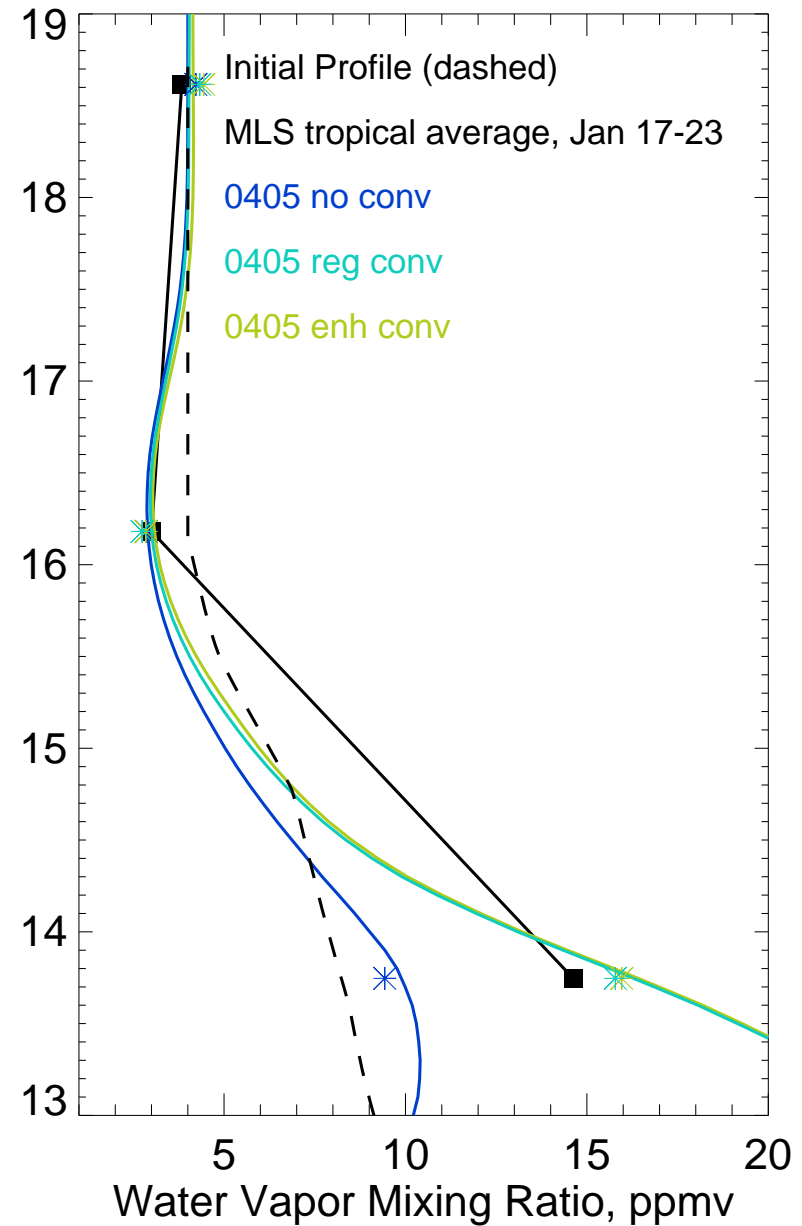
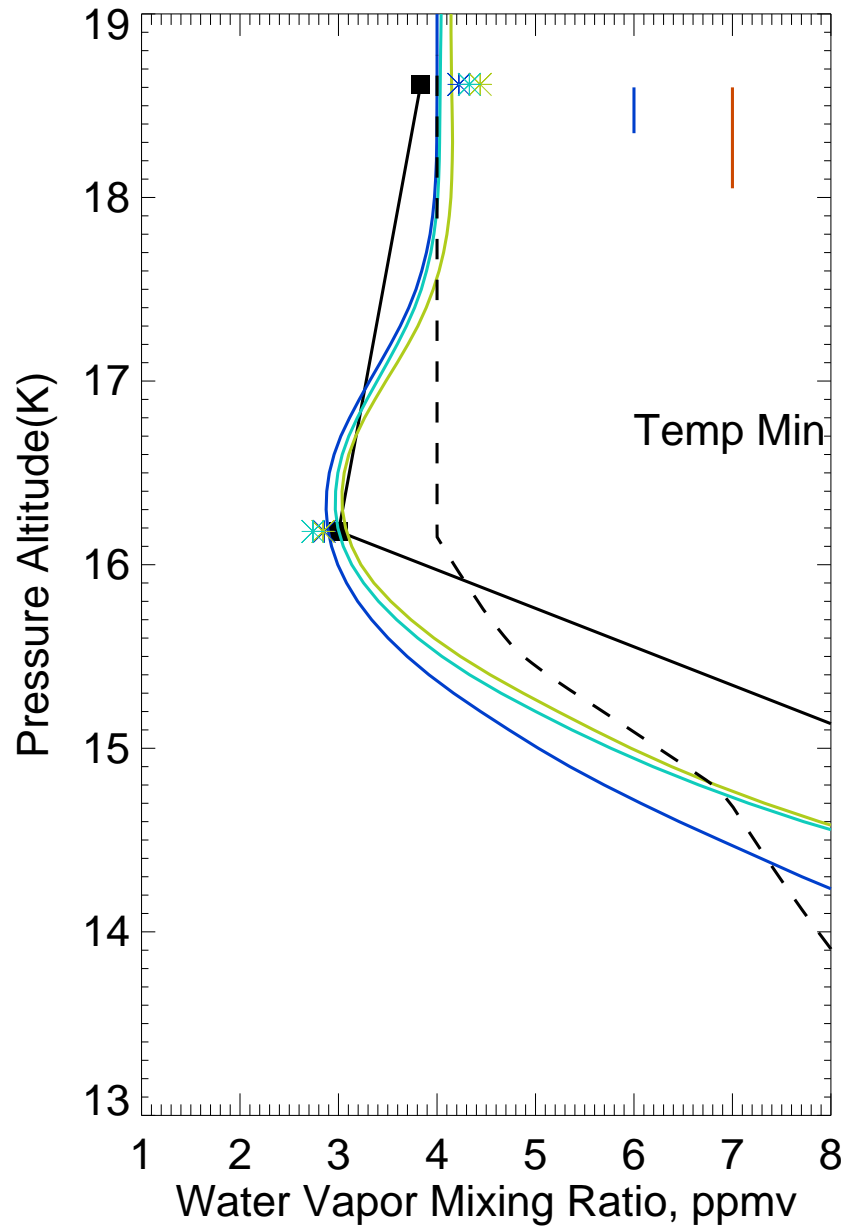




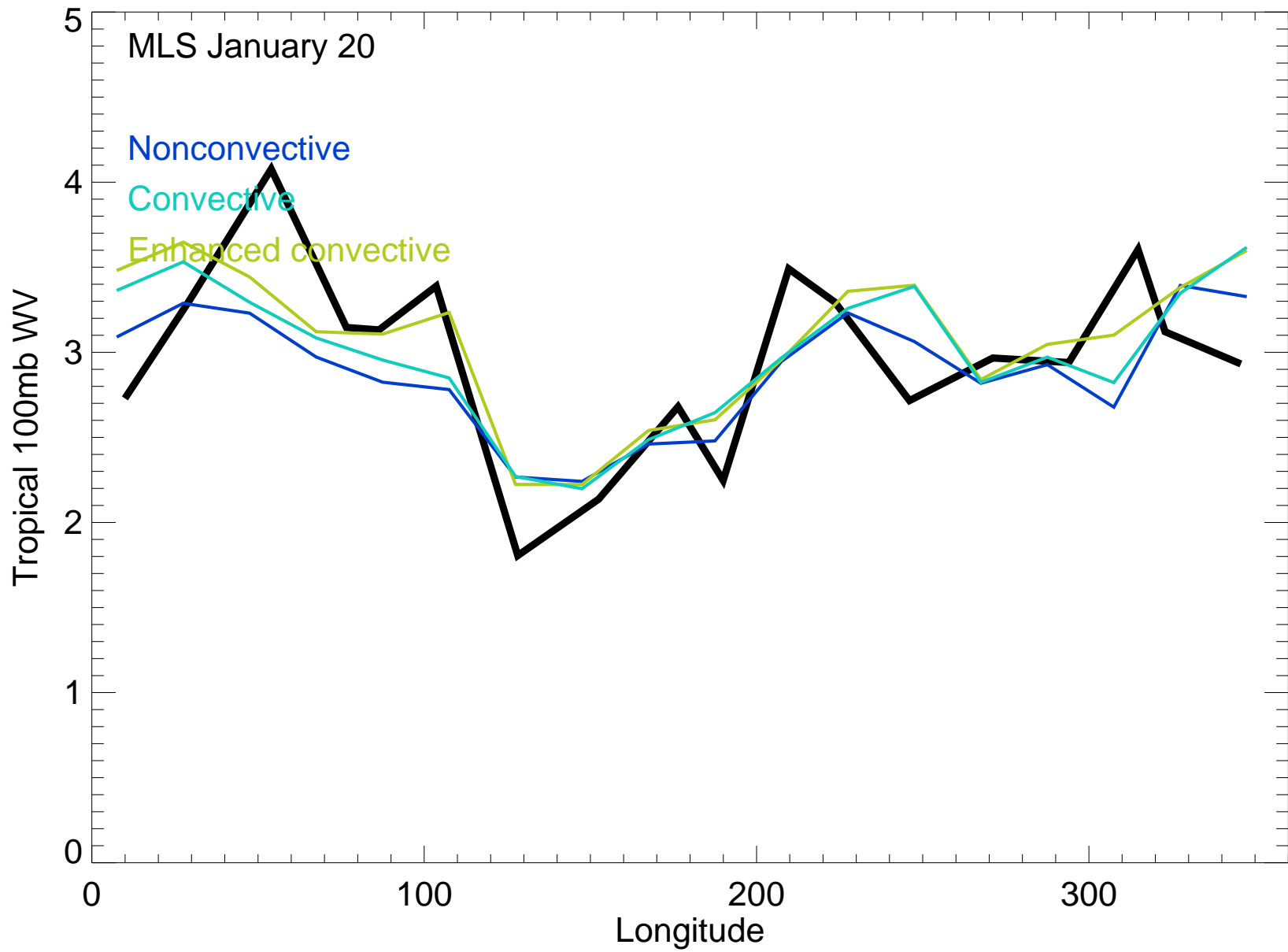
## Sample single trajectory evolution – with convection



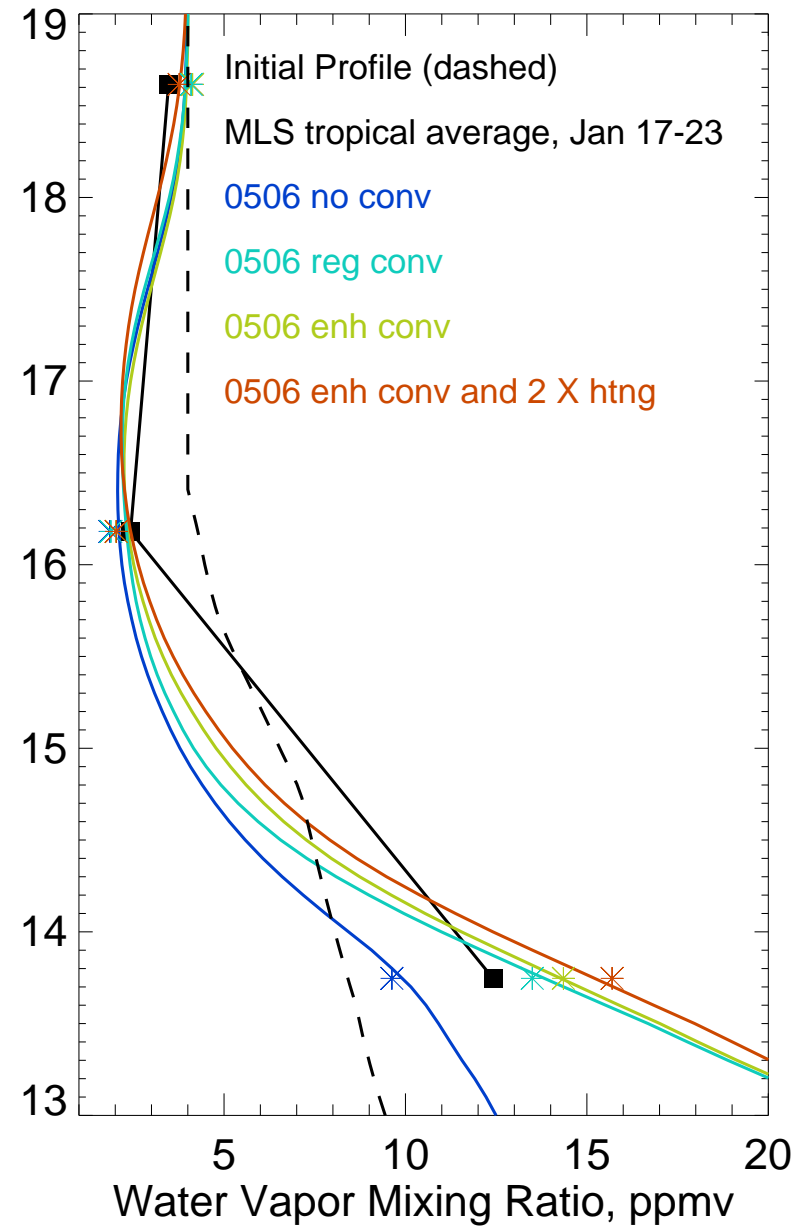
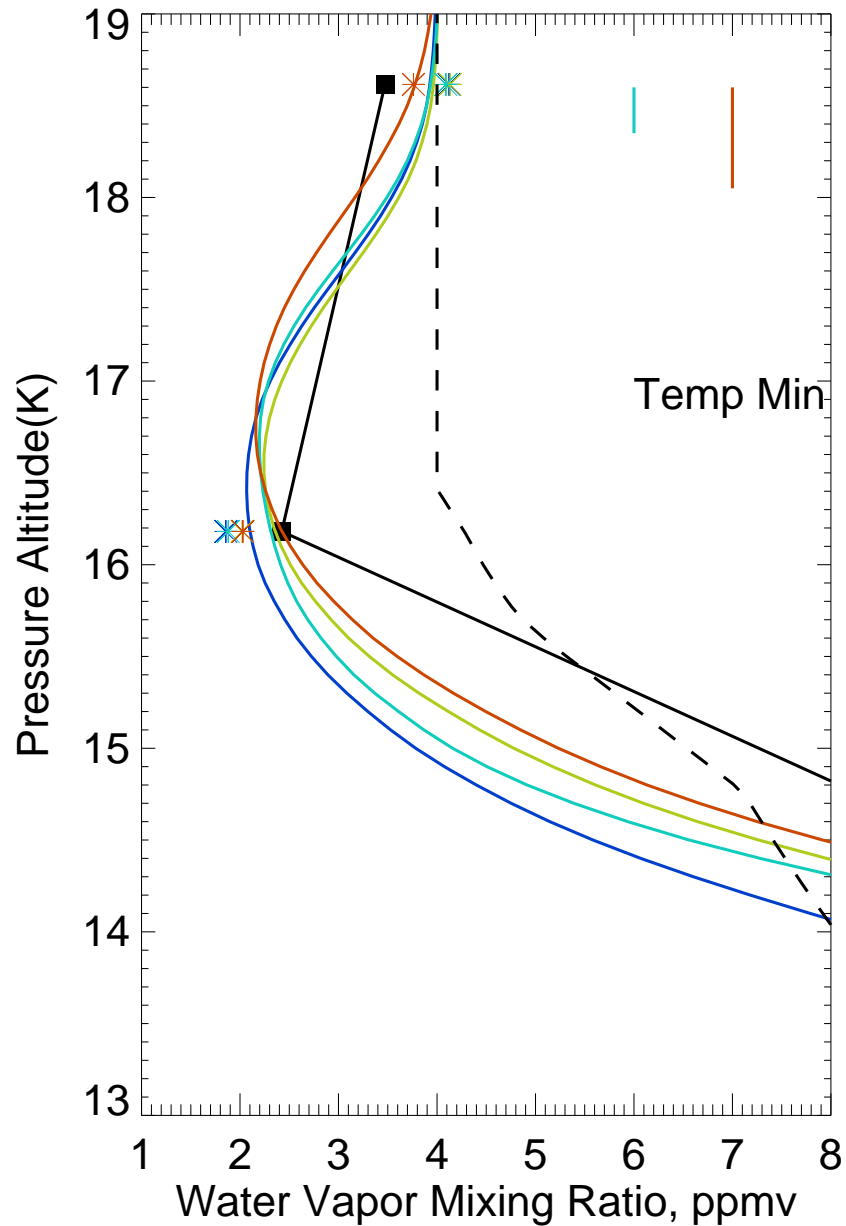
## Tropical (-10 to 10) Vertical Profile, January 20, 2005



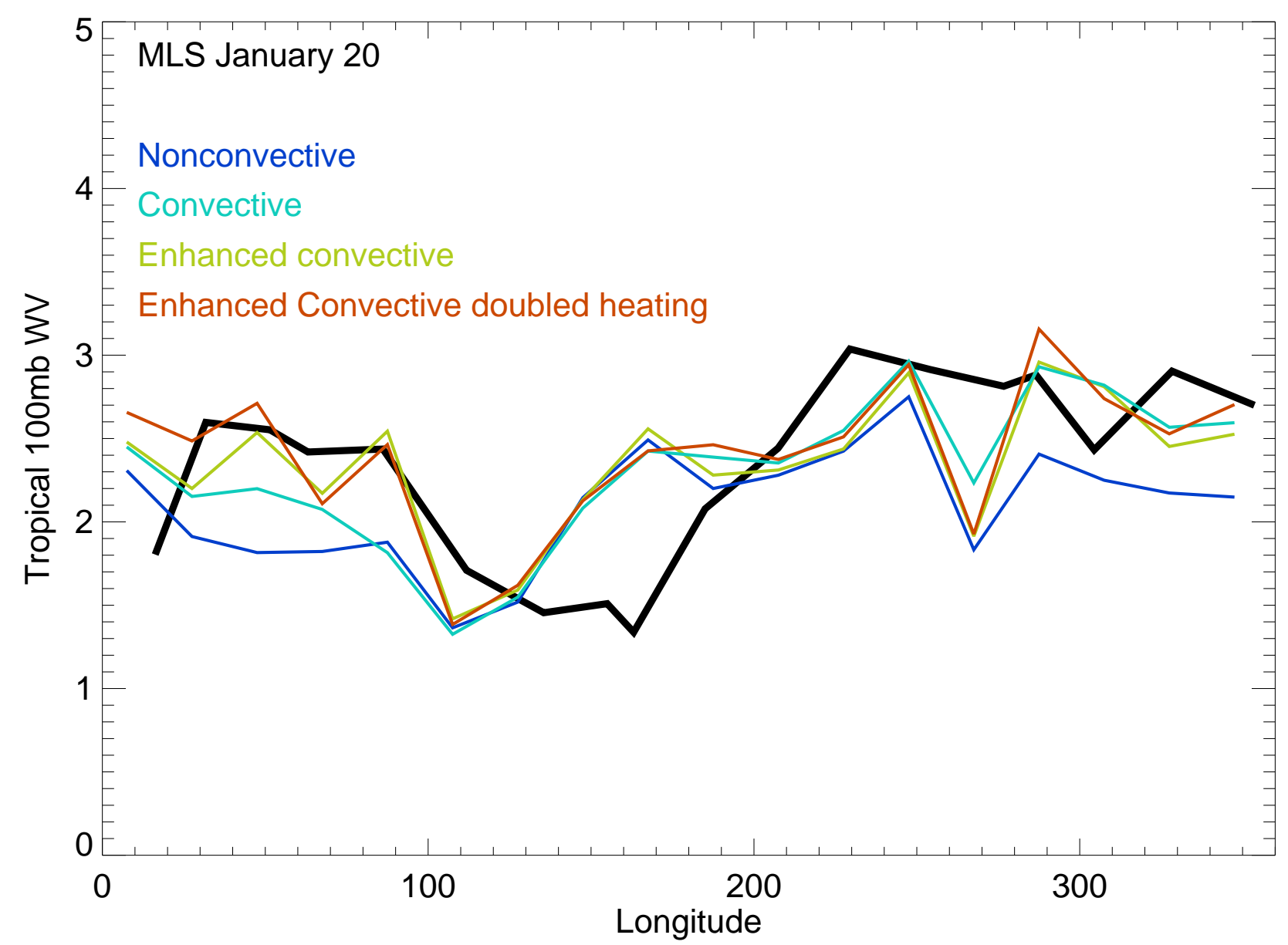
100mb Longitudinal Distribution in the -10 to 10 degree region, January 20, 2005



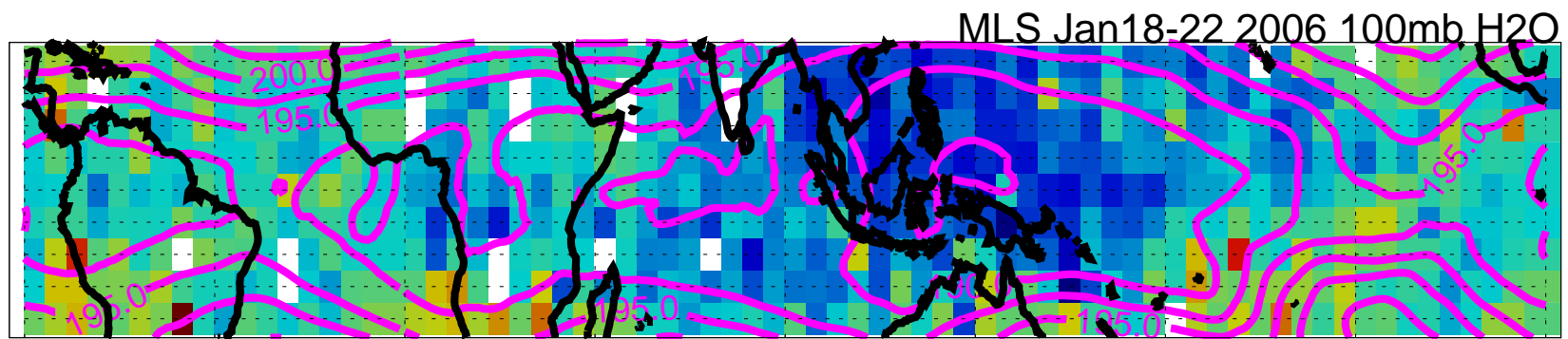
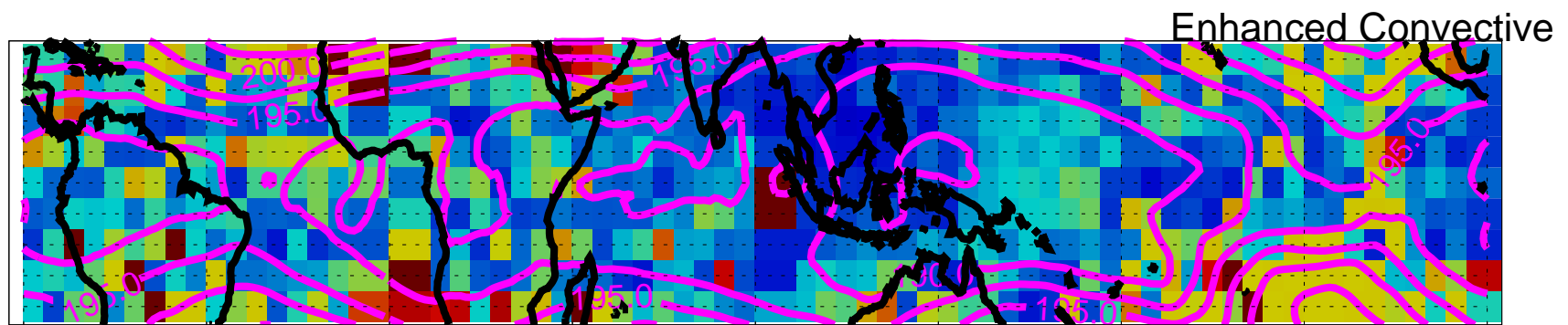
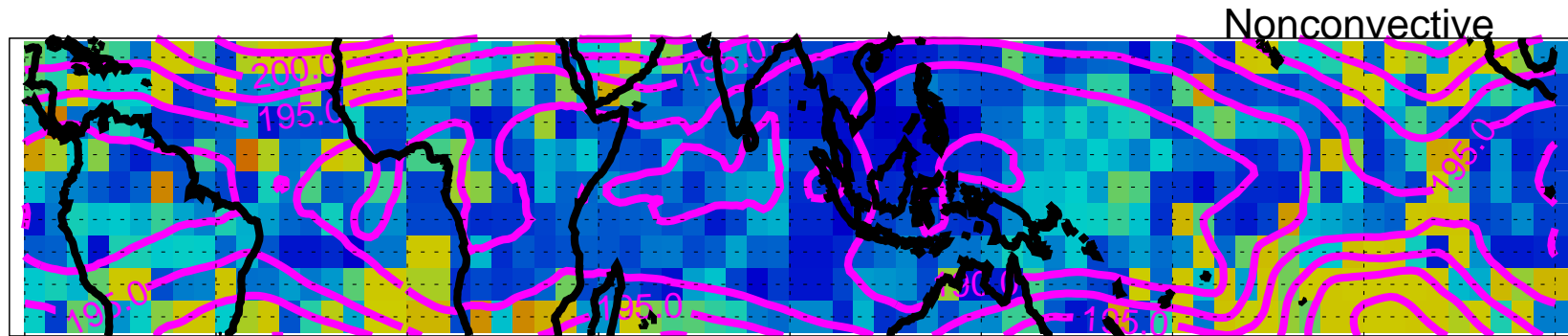
## Tropical (-10 to 10) Vertical Profile, January 20, 2006



100mb Longitudinal Distribution in the -10 to 10 degree region, January 20, 2006



## Water at 100 compared with 5 MLS days in January 2006



1

2

3

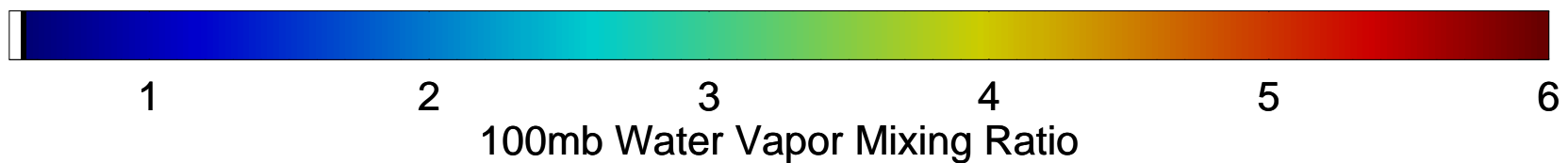
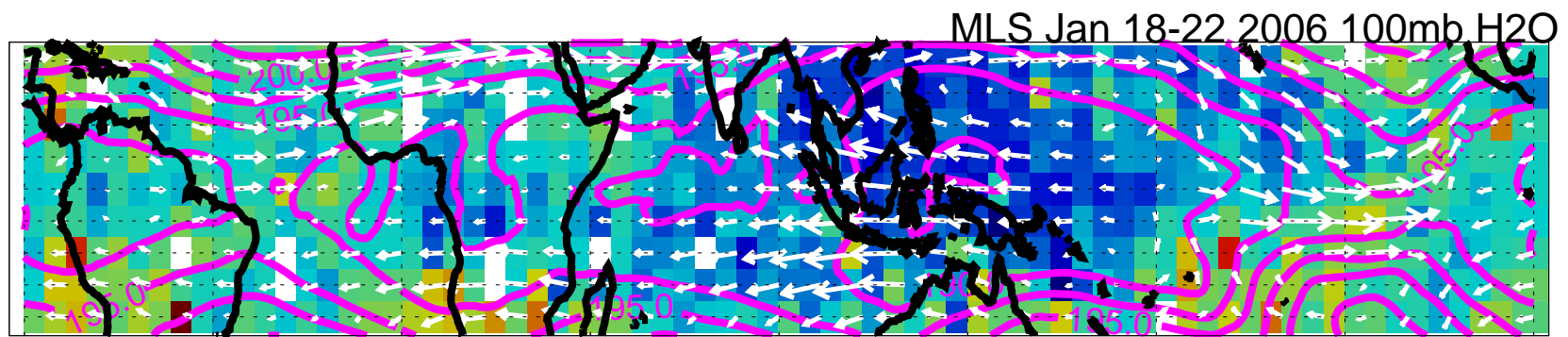
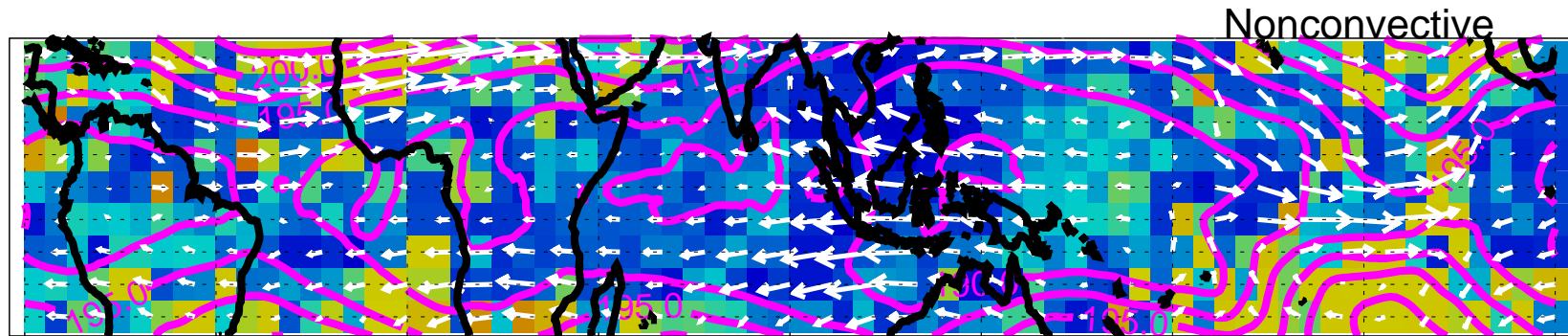
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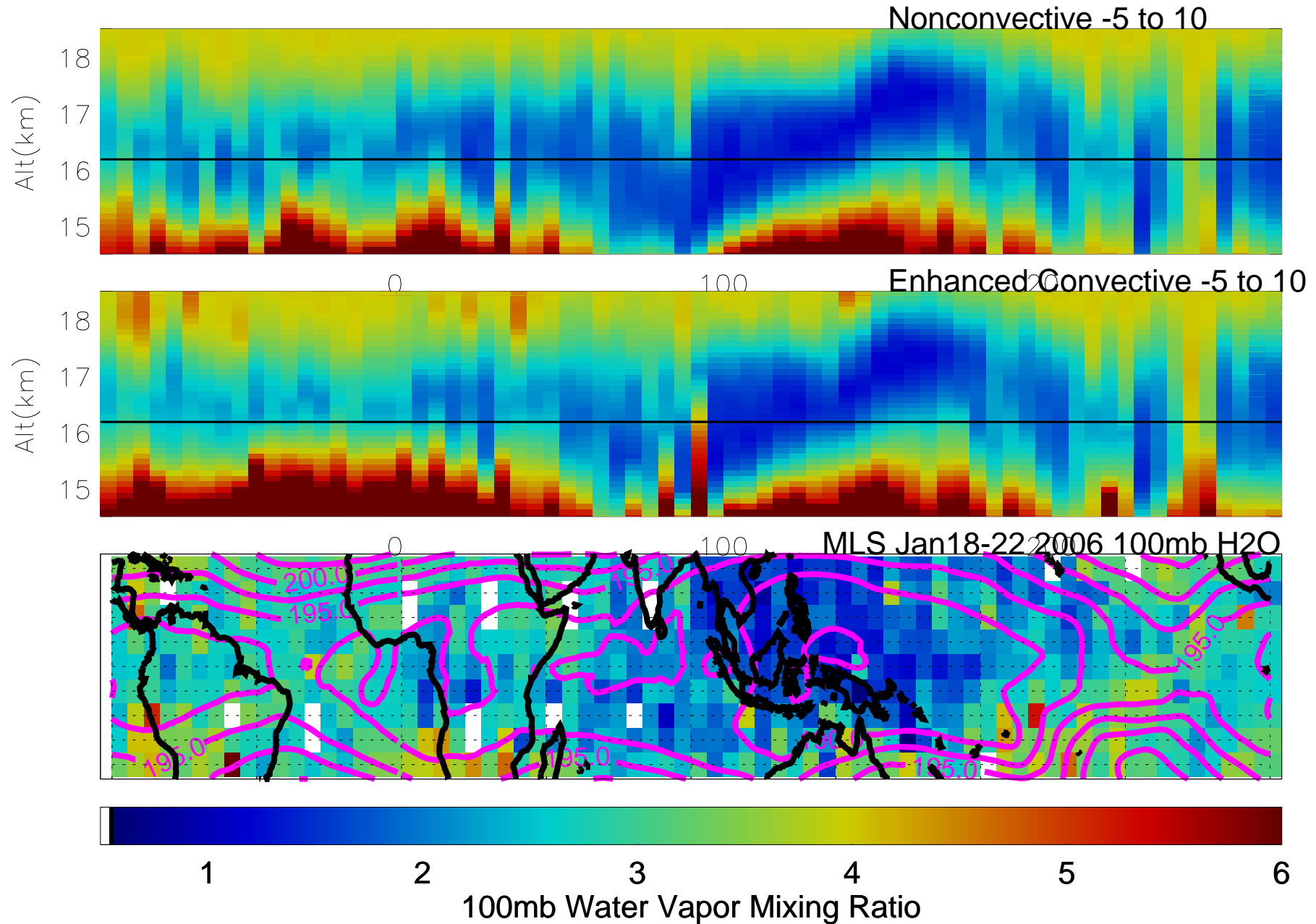
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100mb Water Vapor Mixing Ratio

## Water at 100mb compared with 5 MLS days in January 2006

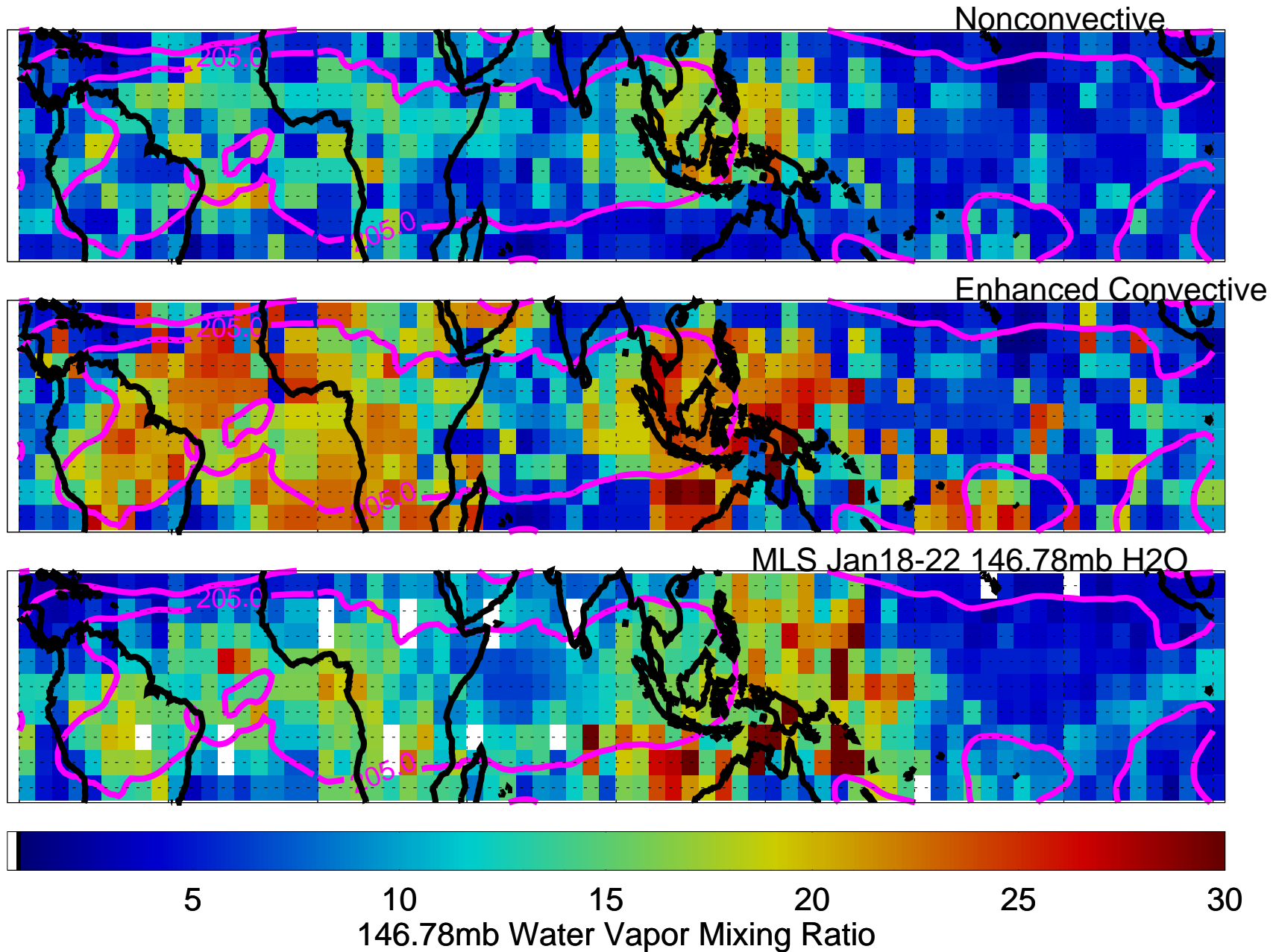


## Water at 100mb (model) compared with 5 MLS days (100mb) in January 2006





## Water at 146.78mb compared with 5 MLS days in January 2006



## Conclusions

- Fidelity of Simulations
  - 146 mb – too moist relative to MLS, but convective simulations clearly capture horizontal structure.
  - 100mb – cold winter (2006) about .5 ppmv too dry on average.
  - 100mb – reasonable horizontal distribution – including output from cold pool
- Convection clearly improves simulation at the bottom and middle of the TTL, with enhanced convection and vertical velocity giving best results.
- Effects of convection on water vapor are small above 370K.

## Open Issues

- Inclusion of sub grid scale gravity waves
- Interactive cloud heating
- Convection we use may be too weak (Turnover times too long)
- So, can we simulate TTL water with conventional microphysics?
- Well, yes, if MLS version 1.5 is true, BUT

## CRAVE region (-5 to 15; 260 to 300) Vertical Profile, Feb 1-9 2006

